Industrial Revolution (IR4.0) Impact on Management

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Abstract: Industry 4.0 refers to the development processes that took place in industries primarily in the manufacturing and chain production departments. The managerial decisions made by executives in industry 4.0 setting has significant impacts on various areas such as technology, data management and analytics, data security, risk management, regulatory compliance, validation, and human resource practices. The fourth industrial revolution will see a massive application of Artificial Intelligence, sensors, enterprise-level solution platforms, and Machine Learning. It is also projected that the volume of external and internal Internet of Things (IoT) data will increase in industry 4.0 and will see a dramatic transformation to information. The IR4.0 will lead to an excess flow of data to quality professionals in real-time and this data will emerge from multiple sources simultaneously calling for intelligent use to enable quick and efficient decision making. The managers and quality management personnel need to make appropriate decisions that will see a smooth transition to digital technology to improve the efficiency and quality of produced goods and services.The fourth industrial revolution will make it compulsory for companies to implement effective risk management strategies with the aim of improving product quality and operational efficiency by allowing machine learning and AI to provide the best services. For that reason, the risk management team needs to draw plans that will see the proper implementation of these strategies. Moreover, the quality managers need to ensure effective implementation of Quality 4.0 or EQMS 4.O that will go hand in hand with the fourth industrial revolution. Previous studies on how industry 4.0 influences managerial decisions have been insufficient and unsatisfactory. Therefore, the paper aims at providing a comprehensive discussion of the impacts of the fourth industrial revolution on management.

1 INTRODUCTION

The fourth industrial revolution, also known as Industry 4.0 (IR4.0), refers to the development processes that took place in manufacturing industries and chain production. The term was initially coined in 2011 with the name “industrie 4.0” with the aim of enhancing the competitiveness of German in the manufacturing industry. Its pioneers came from diversified fields including business, academia, and politics. The federal government of German embraced the idea in its High-Tech Strategy for 2020. Despite industry 4.0 being poised to bring significant changes in various areas of quality management, many professionals still have no idea of how the concept will impact the different things they do. However, it’s evident that many organizational executives are monitoring this paradigm-shifting strategy to garner sufficient information on the direction the change should take. Likewise, quality professionals should be well involved in the monitoring process since they form a pivotal component of Industry 4.0 dialogue for their respective companies. As quality professionals embark into this new era, it’s essential to have a plethora of information regarding understanding the aspects and premises of Industry 4.0 and its impacts on production, quality management system, and the supply chain.

This paper will focus on the Industry 4.0 concept aiming at specific tools for managers that is management. Background of the concept, development plan and current state will be addressed. Some software technological background issues, which reflect essential aspects of Industry 4.0 concept, will be presented. The paper is structured as follows. The second section presents the core idea of Industry 4.0, its origin, goals and elements as well as the adoption of technology in industrial revolution development. Also IoT application/software support delicate balance of digital trust to ensure the privacy of data and transparency of information is addressed in the third section.

In the fourth section the challenges of data secu-

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rity faces by companies for adoption of Industry 4.0 is discussed and in the fifth section, the question of regulatory compliance as Industry 4.0 is different from the current norms of the industry. In the sixth section, the question of risk management arises as the whole way of doing things are different with the aim of improving product quality and operational efficiency. The seventh section looks at the needs for new appropriate strategies. In the eight sections, the various activities of Human resources that need to be modified in order to compliment the application of Industry 4.0 in the industries. Lastly, the final sections are where conclusions are drawn and general topics are discussed. The paper comprehensively reviews the effects of Industry 4.0 on management.

2 THE ROLE OF TECHNOLOGY

Proper implementation of Industry 4.0 will mean that all industrial processes and products will undergo intelligent networking to improve quality and efficiency. Fraunhofer Institute conducted a study in 2013 to review the potential for growth and expansion of companies using IR4 technologies. The findings of the survey indicated five main technologies areas that affect this growth. These include embedded systems, strong networks, IT security, smart factories, and cloud computing (Nagy et al., 2018). A similar study by (Rüßmann et al., 2015), established nine technologies that will mark complete transformation into the industry 4.0. These included automated robots, integrated horizontal and vertical systems, cyber security, 3D printing (additive production), big data analysis, simulation, industrial IoT, cloud-based services, and augmented reality.

The graph below shows some of the industrial transformations from the first to the fourth industrial revolution.

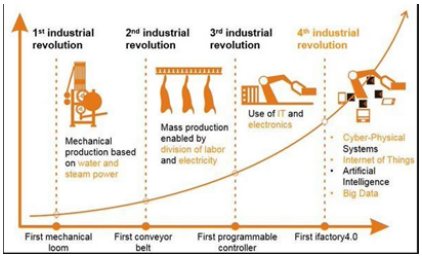

Figure 1: The Industrial Transformations

The above graph implies that the fourth industrial revolution requires machines to be connected as a collaborative community in an industrial setting. It also demands the application of advanced prediction tools to enable systematic processing of data into information to explain uncertainties hence helping in making of informed decisions (Nagy et al., 2018),. Most organizations will demand upgrading of some platforms on quality management systems (QMS) and supply chain to convert the industry into a smart factory that will have the capacity of meeting the requirements of the sector 4.0. Some of the technological changes include substituting old equipment with modernized ones, Artificial Intelligence (AI), implementation of sensors, enterprise-level solution platforms, and Machine Learning (ML). It is also projected that the volume of external and internal IoT data will increase and will see a dramatic transformation to information. Furthermore, IR4 will lead to innovation of predictive analytics that will enhance prevention, and the daily norm will be continuous learning and improvement (Nagy et al., 2018). Therefore, the mangers and quality management personnel need to make appropriate decisions that will see smooth transition to digital technology to improve efficiency and quality of produced goods and services.

3 THE MANAGEMENT OF DATA AND ANALYTICS

Tool	Prevalence Rate in the Sample	Number of observations
CPS	67.4%	28
Big data analytics	62.8%	26
CPPS	53.5%	22
Cloud	32.6%	14
Sensors	30.2%	12
Robot arms	23.3%	10
RFIDs	14%	6
Smart tools	9.3%	4
Smart Products	7%	3
AGV	2.3%	1

Figure 2: List of URLs for digital resources used in the course (partial list.) Source : (Nagy et al., 2018).

It's important to embed data and processes to form an integral part of the ecosystem for the QMS and the employees to succeed and make significant contributions to the bottom-line benefits of the company. The Industry 4.0 will lead to an excess flow of data to quality professionals in real-time and this data will emerge from multiple sources simultaneously calling for intelligent use to enable quick and efficient decision making. The quality management personnel need to derive effective methods of embracing internal and external data and technology and utilize them to cultivate a culture of innovation while enhancing the overall quality (Nagy et al., 2018).The last few years have recorded immense transformations in the IT and telecommunications leading to networking

of electronic devices, also known as the internet of things (IoT) (Wielki, 2017). A study conducted by (Nagy et al., 2018) to determine the application of Internet of Things (IoT) in industries came up with the following prevalence rates at Figure 2.

4 THE CHALLENGES OF SECURITY

Industry 4.0 is projected to result in production of vast volumes of data and information. As a result, it is crucial to ensure the integrity of the data to protect the intellectual property of the company. The healthcare industry will mark a new milestone in producing smart products that have the ability to send and accept data between the machine and human beings (Shrouf et al., 2014). It is thus imperative to ensure that the incoming data is harmless to the device as this guarantees patient safety. The challenge goes back to the manufacturer who is supposed to implement the necessary strategies to ensure the device transmits the right data and information without exposing the IP and details of the patient. This equally calls for a delicate balance of digital trust to ensure the privacy of data and transparency of information (Shrouf et al., 2014).

Data security is an area of concern for organizational leaders since it determines the uniqueness and the competitiveness of the product. The quality management staff must come up with appropriate decisions that will ensure controlled access of data through proper encryption and enhancing the security of networks, sensors, and devices (Hossain and Muhammad, 2016). It is possible for new entrants to evade the market with smart products and other services hence implementing and innovating a more modern form of customer-centric business model that extends the industrial boundaries is of importance. The big question arises on the most appropriate time for taking the plunge. This is because if a specific company waits for too long, the new entrants and the existing competitors get an opportunity to tailor the market and seek to benefit from the learning process (Tesch et al., 2017). As a consequence, the management team needs to make strategic decisions to avoid unnecessary competitions.

5 THE IMPACT ON REGULATORY COMPLIANCE

Many industries are working diligently to examine how machine learning, and artificial knowledge can be leveraged deeply in their daily operations. However, the executive is well aware that this is a challenging task as it is entirely different from the current norm in industries. Artificial intelligence (AI) is one of the technologies that can be potentially useful especially in industry 4.0 setting because it is capable of enhancing deep learning, and thus can help computers to run multiple scenarios at a neck-breaking speed (Moeuf et al., 2018). It can lead to the electric generation and access to vast amounts of data, and this can be easily availed to the broader industry thanks to the cloud storage technology. AI-powered digital twins are useful in detecting anomalies and deviations, as well as simulation and prediction. Digital twin technology is capable of utilizing sensor data to create a digital representation of the existing assets, and then apply specific conditions to learn from the outcomes. Some of these conditions in the healthcare industry include how different sizes of drugs impact the breakdown schedules or the probability of a client developing specific drug adverse effects. The digital twins can then be applied to learn and adapt during this process of discovering new information (Saucedo-Martínez et al., 2018).

Artificial intelligence could present an exciting method of manufacturing medications by running potential simulations and then utilizing the data to drive development and design (Wagner et al., 2017). However, the technology comes with various potential issues since the pharmaceutical industry has strict regulations regarding the manufacture and distribution of drugs. As a result, organizational management needs to work on establishing new standards and procedures to allow AI and other technologies to be adopted (Wagner et al., 2017).

6 THE IMPORTANCE OF RISK MANAGEMENT

Risk management is the process of identifying, analyzing, and responding to threats with the aim of achieving the objectives of the project. Quality professionals cannot deny the pressing needs to establish a fully functional quality risk management system into every QMS process (Kirazli and Moetz, 2015). This is strongly evidenced by the most recent standardization updates done by the EU MDR and ISO 13485:2016 implying that effective risk management is pivotal in the current post-crisis economy (Tupa et al., 2017). It is one of the nine knowledge fields documented by the Project Management Institute (PMI) and is far by far the most complicated component of project management.

Risk management helps organizations to understand the meaning of risk, the people at risk, and risk prevention strategies. If the techniques for preventing risk are adequate, then the risk management personnel need to employ sufficient measures to ensure the risks are managed at reasonable and acceptable levels (Glas and Kleemann, 2016). Nowadays, the law mandates companiesespecially the largescale organizations to implement proper systems of managing risks to enhance the safety of the employees. The fourth industrial revolution will make it compulsory for companies to implement effective risk management strategies with the aim of improving product quality and operational efficiency by allowing machine learning and AI to provide the best services. For that reason, the risk management team needs to draw plans that will see the proper implementation of these strategies (Tupa et al., 2017).

7 THE INFLUENCE OF VALIDATION

Industry 4.0 has various impacts on the validation of machine learning and artificial intelligence which in turn impacts quality operations. Currently, the validation philosophy states that companies should always experience expected results, and the implemented validation techniques and processes should aim at demonstrating that they will attain the expected outcome (Sanders et al., 2016). However, in the IR4 setting, industries should expect to experience unexpected results. The machine learning and artificial intelligence algorithms function by learning, and it's not strange for them to learn something that was not initially anticipated by the algorithm originator. Although the digested results may be unexpected, the available evidence indicates that they may be valid. Therefore, the quality management personnel draw appropriate strategies that will see the implementation of Quality 4.0 or EQMS 4.O that will go hand in hand with the fourth industrial revolution (Sanders et al., 2016).

8 THE HUMAN RESOURCE PRACTICES

A cultural shift is vital for successful implementation of the industry 4.0. The change in cultural practices calls for additional investment in both people and change management. The human resource (HR) practices comprise one of the primary sources that can be applied by companies in shaping the skills, behaviors, attitudes, and abilities of the employees to achieve the goals of the organization (Shamim et al., 2016). The managers need to design effective HR practices that will enhance the innovativeness, learning, and knowledge management capacity among the employees. Some of these HR practices include staffing, training, compensation, performance appraisal, and job design (Prieto and Pérez-Santana, 2014).

8.1 Staffing: the hiring process on industry 4.0 setting should be based on competence, skills, and heterogeneity of knowledge. Therefore, the recruiters should subject individuals to extensive interviews to assess these qualities before employing them. The companies should spend considerable efforts in selecting the appropriate candidates for each job utilizing comprehensive selection and recruitment procedures (Prieto and Pérez-Santana, 2014).

For instance, to employ innovative candidates, the recruiters should concentrate on identifying the qualities that are crucial for innovation, e.g. being open to experience, that can be examined by psychometric testing in the selection procedure. There are various characteristics of a candidate who is open to new experience including active imagination, attentiveness, intellectual curiosity, flexible thinking, inner feeling, variety preferences, and interest. Furthermore, prospective candidates who are open to new experience will demonstrate a positive attitude towards learning (Bonekamp and Sure, 2015). In the selection and recruitment process, employers should consider the candidates with higher learning orientation as this promotes learning and innovation aligning the company goals with those of industry 4.0. Employees with top learning goal orientation are highly interested in participating in challenging tasks, are always ready to improve, have a tendency of achieving mastery, and are more than willing to develop a new set of skills (Kim and Lee, 2013). The hiring manager should also consider the future potential of the candidate and how important he or she will be in contributing to the achievement of the objectives of the fourth industrial revolution.

8.2 Training: in the industry 4.0 setting, organizations should design their training programs in a manner that promotes learning and innovative capability. The educational programs should be comprehensive enough to enable employees to multitask which improve the level of production. The training offered does not need to be directly relevant to the employee's job but should be geared towards increasing the variety of skills (Marques et al., 2017).The training programs should be continuous with refresher courses to remind the employees of their scope, roles, and re-

sponsibilities. They should also focus on building a team and teamwork skills and manager should engage in daily routine mentoring to increase efficiency in production. Moreover, managers should ensure that employees receive training to boost their problem-solving skills (Shamim et al., 2016).

8.3 Compensation: in the industry 4.0 environment, the system of compensating employees should be a reflection of the contributions of the employees towards the company. The organizations should pay the employees based on their individual, group, and organizational performance (Prieto and Pérez-Santana, 2014). The managers should implement strategies that will create a link between job performance and the reward which includes payment of additional incentives and profit sharing. Such a system of compensation enhances a favorable environment for innovation and learning (Prieto and Pérez-Santana, 2014).

8.4 Performance Appraisal: the best suitable performance appraisal for industry 4.0 should focus on improving results, behaviors, and the development of employees. The employees should be updated on their performance daily. Additionally, the performance appraisal should be more of an objective than subjective, and this implies that the performance should be evaluated quantitatively by the use of matrixes (Shamim et al., 2016). An ideal process of performance appraisal should comprise of development of performance standards, communicating the expected results, evaluating the actual performance, comparing the actual performance with the set standards, a discussion of the appraisal with the employees, and implementing corrective measures where necessary. There are many methods of performance appraisal, but management objectives (MBO) are the most commonly used. MBO is a practical performance approach that is compatible with the fourth industrial revolution (Shamim et al., 2016).

8.5 Job design: it is how an industry organizes the tasks in a specific position including how and when the tasks are accomplished and any other factors affecting work like the conditions and the order in which the functions are to be completed. The job design is an essential factor that enhances the climate of learning and innovation and should be characterized by job rotation, extensive transfer of roles to the employees, and flexible assignments in multiple areas. Moreover, the job design should cultivate a culture of teamwork and collaboration (Prieto and Pérez-Santana, 2014). An industry 4.0 setting is characterized by learning and innovation, and as a result, a job design can significantly help the company to adjust to the business environment.

9 CONCLUSIONS

Industry 4.0 refers to the development processes that took place in manufacturing industries and chain production. The fourth industrial revolution is poised to impact various areas of management including technology, data and analytics management, security of data, regulatory compliance, risk management, validation, and HR practices. The industry 4.0 environment is characterized by learning and innovation and influences various HR practices such as training, performance appraisal, compensation, staffing, and job design. In staffing, innovativeness, learning, and knowledge management capacity among the applicant is highly sought. Proper characteristics of a candidate is the one who is open to new experience including active imagination, attentiveness, intellectual curiosity, flexible thinking, inner feeling, variety preferences, and interest. Employee training top learning goal orientation are highly interested in participating in challenging tasks, are always ready to improve, have a tendency of achieving mastery, and are more than willing to develop a new set of skills and should be geared towards increasing the variety of skills. And focus on building a team and teamwork skills to increase efficiency in production. Moreover, managers should implement strategies that will create a link between job performance and the reward which includes payment of additional incentives and profit sharing. Performance appraisal should be more of an objective than subjective, and this implies that the performance should be evaluated quantitatively by the use of matrixes. The last but not least, the job design is an essential factor that enhances the climate of learning and innovation and should be characterized by job rotation, extensive transfer of roles to the employees, and flexible assignments in multiple areas. Moreover, the job design should cultivate a culture of teamwork and collaboration. Therefore, the managers should implement strategies that have positive impacts on these factors to facilitate the culture of industry 4.0. The fourth industrial revolution will increase the efficiency and quality of the produced goods and services.

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REFERENCES

Bonekamp, L. and Sure, M. (2015). Consequences of industry 4.0 on human labour and work organisation. *Journal of Business and Media Psychology*, 6(1):33–40.

Glas, A. H. and Kleemann, F. C. (2016). The impact of industry 4.0 on procurement and supply management: A conceptual and qualitative analysis. *International Journal of Business and Management Invention*, 5(6):55–66.

Hossain, M. S. and Muhammad, G. (2016). Cloud-assisted industrial internet of things (iiot)–enabled framework for health monitoring. *Computer Networks*, 101:192–202.

Kim, T. T. and Lee, G. (2013). Hospitality employee knowledge-sharing behaviors in the relationship between goal orientations and service innovative behavior. *International Journal of Hospitality Management*, 34:324–337.

Kirazli, A. and Moetz, A. (2015). A methodological approach for evaluating the influences of industrie 4.0 on risk management of the goods receiving area in a german automotive manufacturer. In *22nd EurOMA Conference: Operations Management for Sustainable Competitiveness*.

Marques, M., Agostinho, C., Zacharewicz, G., and Jardim-Gonçalves, R. (2017). Decentralized decision support for intelligent manufacturing in industry 4.0. *Journal of Ambient Intelligence and Smart Environments*, 9(3):299–313.

Moeuf, A., Pellerin, R., Lamouri, S., Tamayo-Giraldo, S., and Barbaray, R. (2018). The industrial management of smes in the era of industry 4.0. *International Journal of Production Research*, 56(3):1118–1136.

Nagy, J., Oláh, J., Erdei, E., Máté, D., and Popp, J. (2018). The role and impact of industry 4.0 and the internet of things on the business strategy of the value chain—the case of hungary. *Sustainability*, 10(10):3491.

Prieto, I. M. and Pérez-Santana, M. P. (2014). Managing innovative work behavior: the role of human resource practices. *Personnel Review*.

Rüßmann, M., Lorenz, M., Gerbert, P., Waldner, M., Justus, J., Engel, P., and Harnisch, M. (2015). Industry 4.0: The future of productivity and growth in manufacturing industries. *Boston Consulting Group*, 9(1):54–89.

Sanders, A., Elangeswaran, C., and Wulfsberg, J. P. (2016). Industry 4.0 implies lean manufacturing: Research activities in industry 4.0 function as enablers for lean manufacturing. *Journal of Industrial Engineering and Management (JIEM)*, 9(3):811–833.

Saucedo-Martínez, J. A., Pérez-Lara, M., Marmolejo-Saucedo, J. A., Salais-Fierro, T. E., and Vasant, P. (2018). Industry 4.0 framework for management and operations: a review. *Journal of ambient intelligence and humanized computing*, 9(3):789–801.

Shamim, S., Cang, S., Yu, H., and Li, Y. (2016). Management approaches for industry 4.0: A human resource management perspective. In *2016 IEEE Congress on Evolutionary Computation (CEC)*, pages 5309–5316. IEEE.

Shrouf, F., Ordieres, J., and Miragliotta, G. (2014). Smart factories in industry 4.0: A review of the concept and of energy management approached in production based on the internet of things paradigm. In *2014 IEEE international conference on industrial engineering and engineering management*, pages 697–701. IEEE.

Tesch, J. F., Brillinger, A.-S., and Bilgeri, D. (2017). Internet of things business model innovation and the stage-gate process: An exploratory analysis. *International Journal of Innovation Management*, 21(05):1740002.

Tupa, J., Simota, J., and Steiner, F. (2017). Aspects of risk management implementation for industry 4.0. *Procedia Manufacturing*, 11:1223–1230.

Wagner, T., Herrmann, C., and Thiede, S. (2017). Industry 4.0 impacts on lean production systems. *Procedia Cirp*, 63:125–131.

Wielki, J. (2017). The impact of the internet of things concept development on changes in the operations of modern enterprises. *Polish Journal of Management Studies*, 15.